I. Introduction

The Clean Water Act (CWA) requires a Total Maximum Daily Load (TMDL) be developed for those water bodies identified as impaired by a state where technology-based and other controls will not provide for attainment of water quality standards. A TMDL is a determination of the amount of a pollutant from point, nonpoint, and natural background sources, including a margin of safety (MOS), that may be discharged to a water quality-limited water body.

This document will set forth the Environmental Protection Agency's (EPA) rationale for approving the TMDLs for the aquatic life use (benthic) impairment for Mill Creek and Pleasant Run. EPA's rationale is based on the determination that the TMDLs meet the following eight regulatory conditions pursuant to 40 CFR §130.

1) The TMDLs are designed to implement applicable water quality standards.
2) The TMDLs include a total allowable load as well as individual waste load allocations and load allocations.
3) The TMDLs consider the impacts of background pollutant contributions.
4) The TMDLs consider critical environmental conditions.
5) The TMDLs consider seasonal environmental variations.
6) The TMDLs include a margin of safety.
7) There is reasonable assurance that the TMDLs can be met.
8) The TMDLs have been subject to public participation.

II. Background

The Mill Creek and Pleasant Run watersheds are located in Rockingham County, Virginia. The Mill Creek watershed is 9,636-acres in size. The Pleasant Run watershed is 5,309-acres in size. The TMDLs address a 2.66-mile segment of Mill Creek and a 6.3-mile segment of Pleasant Run. The Mill Creek segment begins at its headwaters and terminates at its confluence with North River. The Pleasant Run segment begins at its headwaters and terminates at its confluence with North River. Agricultural lands make up 68 percent of the 9,636-acre Mill Creek watershed. Residential and forested lands make-up the remaining 32 percent of the Mill Creek watershed. Agricultural lands make up 68 percent of the Pleasant Run watershed. Developed and forested lands account for an additional 31 percent with 1 percent of the watershed made up of water.

In response to Section 303(d) of the CWA, the Virginia Department of Environmental Quality (VADEQ) listed 2.66 and 6.3 miles of Mill Creek and Pleasant Run on Virginia's 1998 Section 303(d)

list as being unable to attain the general standard for aquatic life use and being impaired by elevated levels of fecal coliform. Both streams were unable to attain either standard. The failure to attain the general standard for aquatic life use was determined through biological assessments of the benthic macroinvertebrate community. This decision rationale will address the TMDLs for the impairment of the aquatic life use. Separate decision rationales and TMDLs have been developed for the fecal coliform impairments on Mill Creek and Pleasant Run. The fecal coliform TMDLs for Mill Creek and Pleasant Run were submitted to and approved by EPA in 2001.

Virginia 305(b)/303(d) guidance states that support of the aquatic life beneficial use is determined by the assessment of conventional pollutants (dissolved oxygen, pH, and temperature); toxic pollutants in the water column, fish tissue, and sediments; and biological evaluation of benthic community data.[1] Therefore, a biological assessment of the benthic community can be used to determine a stream's compliance with the state's general standard for aquatic life use. Virginia uses EPA's Rapid Bioassessment Protocol (RBPII) to determine status of a stream's benthic macroinvertebrate community.[2] This approach evaluates the benthic macroinvertebrate community between a monitoring site and its reference station. Measurements of the benthic community, called metrics, are used to identify differences between monitored and reference stations.[3]

Reference stations are established on streams which are minimally impacted by humans and have a healthy benthic community. Streams that are classified as moderately or severely impaired after an RBPII evaluation are classified as impaired and are placed on the Section 303(d) list of impaired waters. During the 1998 assessment period, Mill Creek was identified as being moderately impaired while Pleasant Run was evaluated as severely impaired. Both streams continue to be assessed as impaired.

The RBPII assesses the health of the macroinvertebrate community of a stream. The analysis will inform the biologist if the stream's benthic community is impaired. However, it will not inform the biologist as to what is causing the degradation of the benthic community. Additional analysis is required to determine the pollutants which are causing the impairment. TMDL development requires the identification of impairment causes and the establishment of numeric endpoints that will allow for the attainment of designated uses and water quality criteria.[4] A reference watershed approach was used to

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[1]VADEQ. 1997. 1998 Water Quality Assessment Guidance for 305(b) Water Quality Report and 303(d) TMDL Priority List Report. Richmond, VA.

[2]Tetra Tech 2002. Total Maximum Daily Load (TMDL) Development for Blacks Run and Cooks Creek. Fairfax, Virginia.

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determine the stressors and the endpoints for these TMDLs. Numeric endpoints represent the water quality goals that are to be achieved through the implementation of the TMDL and will allow a stream to attain its designated uses. A reference watershed approach is based on selecting a non-impaired watershed that shares similar land use, ecoregion, and geomorphological characteristics with the impaired watershed.[5] The stream conditions and loadings in the reference stream are assumed to be the conditions needed for the impaired stream to attain standards.

To determine whether a stream was a suitable reference site for the monitored sites, the modelers evaluated the topography, soils, ecoregion, land uses, watershed size, and point source inventory of the potential reference site. All reference site candidates had to score slightly impaired or better in the biomonitoring analysis. It should be noted that there were no potential reference sites (unimpaired streams) with an urban land use greater than 6 percent. The reference site selected for both Mill Creek and Pleasant Run was Hays Creek.

The TMDL modelers evaluated all of the streams against the Virginia Ridge and Valley Multimetric Bioassessment Index (VRVMBI) which was developed specifically for Virginia's Benthic TMDLs. This method evaluated the streams against a subset of the RBPII metrics and other data. For additional information on reference site selection or the VRVMBI, please see Section 2.3 of the TMDL document.

The next step in the TMDL development process was to determine the loadings and stressors in the monitored and reference watersheds. Low dissolved oxygen (DO), sedimentation, habitat modification, and toxic pollutants were evaluated as possible stressors to the monitored streams. Ambient water quality monitoring (AWQM) on all the streams documented temperature, DO, pH, turbidity, total suspended solids (TSS), ammonia, nitrates, total phosphorous, and fecal coliform. To get a better understanding of the daily DO concentrations, a diel DO analysis was conducted during the week of June 10, 2002. The summer season is when one would expect the lowest DO concentrations to be found due to a combination of high water temperatures (lower solubility of oxygen) and low flows. DO concentrations and temperatures were evaluated over five-minute intervals for a 24-hour period each day. This data was extrapolated to document the daily DO cycles encountered around the AWQM station.

Toxicity testing was also conducted for water samples collected from the monitored sites. Water samples were collected from the impaired streams on June 3, 5, and 7, 2002. The testing compared the survival and reproduction rates or fathead minnows and *Ceriodaphnia Dubia* in water collected from the impaired sites with an unimpaired source. The test did not document any adverse effects associated with fathead minnows or *Ceriodaphnia Dubia* reared in water from Mill Creek or Pleasant Run. After this analysis, toxicity was not viewed as an issue on the monitored sites.

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In general, the monitored sites had poorer water quality than the reference sites, please see Section 3.0 of the TMDL document for additional information. The analysis concluded that low DO, due to excessive phosphorous, was a problem on both Mill Creek and Pleasant Run. AWQM data indicating elevated levels of TSS and turbidity on both monitored sites, identified sedimentation as a stressor to both streams. Habitat alteration (lack of riparian buffers) was also seen as a problem on both streams but not specifically included in the TMDL.

The next step in developing these TMDLs was to determine the loadings of phosphorous and sediment (the stressors) to the monitored and reference segments. The Generalized Watershed Loading Functions (GWLF) model was selected as the means to determine loadings to the streams. The GWLF model provides the ability to simulate runoff, sediment, and nutrient loadings from watersheds given variable source areas (e.g., agricultural, forested, and developed land).[6] GWLF is a continuous simulation model that uses daily time steps for weather data and water balance calculations.[7] Monthly calculations are made for sediment and nutrient loads, based on daily water balance totals that are summed to give monthly values.[8] To equate the reference watersheds with the monitored watersheds, the reference watersheds were reduced in size to that of the impaired watershed in the model, the land uses were proportionally reduced based on the percent land use distribution. Therefore, the land use breakdown in the reference watersheds remained constant.

Local rainfall and temperature data were needed to simulate the hydrology. The Dale Enterprise weather station was used for temperature and precipitation data for Mill Creek and Pleasant Run. The Lexington (temperature) and Kerrs Creek (precipitation) weather stations were used for the Hays Creek model. Since there was no gage on Hays Creek, the hydrology calibration for Hays Creek was transferred from Kerrs Creek. Neither Mill Creek nor Pleasant Run had daily stream flow measurements. Therefore, it was necessary to model the hydrology of nearby Linville Creek and transfer that model to our impaired watersheds. The transferred hydrology model was compared to the observed (monthly) data on Mill Creek and Pleasant Run.

Table 1 - Summarizes the Specific Elements of the TMDLs.

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Segment	Parameter	TMDL (lbs/yr)	WLA (lbs/yr)	LA (lbs/yr)	MOS (lbs/yr)*
Mill Creek	Sediment	6,967,698	276	6,270,928	696,770
	Phosphorous	6,001	138	5,401	600
Pleasant Run	Sediment	4,411,231	0	3,970,108	441,123
	Phosphorous	3,910	0	3,519	391

* Virginia includes an explicit MOS by reserving the 10 percent of total loading to the MOS.

The United States Fish and Wildlife Service has been provided with copy of this TMDL.

III. Discussion of Regulatory Conditions

EPA finds that Virginia has provided sufficient information to meet all of the eight basic requirements for establishing aquatic life use (benthic) impairment TMDLs for Mill Creek and Pleasant Run. EPA is therefore approving these TMDLs. Our approval is outlined according to the regulatory requirements listed below.

1) The TMDL is designed to meet the applicable water quality standards.

The monitored sites were listed as impaired due to a degradation of the benthic macroinvertebrate community. As mentioned above, benthic assessments inform the biologist of an impairment, but they are unable to identify a stressor. Therefore a reference watershed approach was used to identify the stressors to these streams. Virginia has indicated that excessive levels of sediment and phosphorous have caused the degradation of the benthic communities on Mill Creek and Pleasant Run. The Commonwealth does not have numeric standards for either nutrients or sediment. Therefore, the loading obtained from the reference watershed was used as the TMDL endpoints. Its believed that if these loadings are obtained, that the impairment to the benthic community will be relieved.

The GWLF model was used to determine the loading rates of sediment and phosphorous from the land as well as loadings to the stream from direct deposit sources. The TMDL modelers determined the sediment and phosphorous loading rates within each watershed. Data used in the model was obtained on a wide array of items, including farm practices in the area, the amount and concentration of farm animals, point sources in the watershed, wildlife in the watershed, land uses, weather, stream geometry, etc..

The GWLF model provides the ability to simulate runoff, sediment, and nutrient loadings from watersheds given variable source areas (e.g., agricultural, forested, and developed land).[9] GWLF is a

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continuous simulation model that uses daily time steps for weather data and water balance calculations.[10] To equate the reference watershed with the monitored watersheds, the reference watershed was reduced in size in the model. Each land-use was reduced in equal proportion, insuring that the land use breakdown in the reference watershed remained constant. Local rainfall and temperature data were needed to simulate the hydrology, this data was obtained from different sources for each watershed. In the GWLF model, the nonpoint source load calculation is affected by terrain conditions, such as the amount of agricultural land, land slope, soil erodibility, farming practices used in the area, and background concentrations of nutrients in soil and groundwater.[11] Parameters within the model account for these conditions and practices and were adjusted to insure that the hydrology and water quality calibrations matched the observed conditions as closely as possible.

EPA believes that using GWLF to model and allocate sediment and phosphorous loadings to the monitored segments will ensure that the designated uses and water quality standards will be attained and maintained on these streams.

2) The TMDL includes a total allowable load as well as individual waste load allocations and load allocations.

Total Allowable Loads

Virginia indicates that the total allowable loading is the sum of the loads allocated to land based precipitation driven nonpoint source areas (forest and agricultural land segments) and point sources. Activities that increase the levels of nutrients and sediment to the land surface or their availability to runoff are considered flux sources. The actual value for total loading can be found in Table 1 of this document. The total allowable load is calculated on an annual basis.

Waste Load Allocations

Virginia has stated that there are three small point sources discharging within the Mill Creek watershed. All of these facilities are single family waste water treatment facilities. These facilities are covered by a VPDES general permit. The general permit calls for a Total Suspended Solids (TSS) limit of 30mg/L and a flow of less than or equal to 1,000 gallons per day. The annual sediment loading from these facilities can be found in Table 2a, and was calculated by multiplying the concentration of sediment by the design flow. Table 2b, documents the phosphorous loading which is based on an effluent concentration of 15 mg/L.

EPA regulations require that an approvable TMDL include individual WLAs for each point

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source. According to 40 CFR 122.44(d)(1)(vii)(B), "Effluent limits developed to protect a narrative water quality criterion, a numeric water quality criterion, or both, are consistent with assumptions and requirements of any available WLA for the discharge prepared by the state and approved by EPA pursuant to 40 CFR 130.7." Furthermore, EPA has authority to object to the issuance of any National Pollutant Discharge Elimination System (NPDES) permit that is inconsistent with the WLAs established for that point source.

Table 2a - TSS WLAs for Mill Creek

Stream	Facility	Permit Number	Allocated Load (lbs/yr)
Mill Creek	Single Family Unit	VAG40	92
Mill Creek	Single Family Unit	VAG40	92
Mill Creek	Single Family Unit	VAG40	92

Table 2b - Phosphorous WLAs for Mill Creek

Stream	Facility	Permit Number	Allocated Load (lbs/yr)
Mill Creek	Single Family Unit	VAG40	46
Mill Creek	Single Family Unit	VAG40	46
Mill Creek	Single Family Unit	VAG40	46

Load Allocations

According to Federal regulations at 40 CFR 130.2(g), LAs are best estimates of the loading, which may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting loading. Wherever possible, natural and nonpoint source loads should be distinguished.

In order to accurately simulate landscape processes and nonpoint source loadings, VADEQ used the GWLF model to represent the impaired watersheds. The GWLF model is a comprehensive modeling system for the simulation of watershed hydrology, point and nonpoint source loadings, and receiving water quality. GWLF uses precipitation data for continuous and storm event simulation to determine total loading to the impaired segments from the various land uses within the watershed.

Table 3a - LA for Sediment for Mill Creek

Land Use	Existing Load (lbs/yr)	Allocated Load	Percent Reduction
Row Crops	7,394,392	4,066,916	45
Pasture/Hay	3,517,849	1,934,817	45
Forest	26,308	26,308	0
Urban (grouped pervious and impervious areas)	364,670	120,123	37
Transitional	42,270	12,765	70
Water	0	0	0
Groundwater	0	0	0
Point Sources	276	276	0
Septic Systems	0	0	0
Total Existing Load	11,345,765	6,161,205	45

Table 3b -LA for Phosphorous Mill Creek

Land Use	Existing Load (lbs/yr)	Allocated Load (lbs/yr)	Percent Reduction
Row Crops	6,203	2,188	65
Pasture/Hay	2,811	1,124	60
Transitional	28	14	50
Forest	18	18	0
Urban (grouped pervious and impervious)	1,758	1,055	40
Water	0	0	0
Groundwater	782	782	0
Point Sources	138	138	0
Septic Systems	438	219	50
Total	12,176	5,537	54

Table 3c - LA for Sediment for Pleasant Run

Land Use	Existing Load (lbs/yr)	Allocated Load (lbs/yr)	Percent Reduction
Row Crops	10,177,827	3,007,955	70
Pasture/Hay	2,482,016	734,632	70
Transitional/Barren	377,117	73,719	80
Forest	16,505	16,505	0
Urban (grouped pervious and impervious)	457,657	137,297	70
Groundwater	0	0	0
Point Sources	0	0	0
Septic Systems	0	0	0
Water	0	0	0
Total	13,511,122	3,970,108	71

Table 3d - LA for Phosphorous for Pleasant Run

Land Use	Existing Load (lbs/yr)	Allocated Load (lbs/yr)	Percent Reduction
Row Crops	6,809	2,022	70
Pasture/Hay	1,814	542	70
Transitional/Barren	235	47	80
Forest	11	11	0
Urban (grouped pervious and impervious)	864	259	70
Groundwater	433	433	0
Point Sources	0	0	0
Septic Systems	239	204	15
Water	0	0	0
Total	10,404	3,519	66

3) The TMDL considers the impacts of background pollution.

The TMDLs considered background loadings for the pollutant of concern in the analysis.

4) The TMDL considers critical environmental conditions.

According to the EPA regulation 40 CFR 130.7 (c)(1), TMDLs are required to take into account critical conditions for stream flow, loading, and water quality parameters. The intent of this requirement is to ensure that the water quality of the Mill Creek and Pleasant Run is protected during times when it is most vulnerable.

Critical conditions are important because they describe the factors that combine to cause a violation of water quality standards and will help in identifying the actions that may have to be undertaken to meet water quality standards[12]. Critical conditions are a combination of environmental factors (e.g., flow, temperature, etc.), which have an acceptably low frequency of occurrence. In specifying critical conditions in the waterbody, an attempt is made to use a reasonable "worst-case" scenario condition. For example, stream analysis often uses a low-flow (7Q10) design condition because the ability of the waterbody to assimilate pollutants without exhibiting adverse impacts is at a minimum. These critical conditions ensure that water quality standards will be met for other than worst case scenarios. By using the GWLF model, the modelers insured that all flow conditions were taken into account for loading calculations by modeling the TMDL over an extended period of time.

5) The TMDLs consider seasonal environmental variations.

Seasonal variations involve changes in stream flow as a result of hydrologic and climatological patterns. In the continental United States, seasonally high flows normally occur in early spring from snow melt and spring rain, while seasonally low flows typically occur during the warmer summer and early fall drought periods. Consistent with our discussion regarding critical conditions, the GWLF model and TMDL analysis effectively considered seasonal environmental variations through the use of observed weather data. The model also accounted for the seasonal variation in loading by adjusting the vegetative cover and manure application rates based on the time of year. For example, vegetative cover was lower during the winter months.

6) The TMDLs include a margin of safety.

This requirement is intended to add a level of safety to the modeling process to account for any uncertainty. The MOS may be implicit, built into the modeling process by using conservative modeling assumptions, or explicit, taken as a percentage of the WLA, LA, or TMDL. Virginia includes an explicit MOS by allocating 10 percent of the total TMDL loading to the MOS.

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[12]EPA memorandum regarding EPA Actions to Support High Quality TMDLs from Robert H. Wayland III, Director, Office of Wetlands, Oceans, and Watersheds to the Regional Management Division Directors, August 9, 1999.

7) There is a reasonable assurance that the TMDL can be met.

EPA requires that there be a reasonable assurance that the TMDL can be implemented. WLAs will be implemented through the NPDES permit process. According to 40 CFR 122.44(d)(1)(vii)(B), the effluent limitations for an NPDES permit must be consistent with the assumptions and requirements of any available WLA for the discharge prepared by the state and approved by EPA. Furthermore, EPA has authority to object to issuance of an NPDES permit that is inconsistent with WLAs established for that point source.

Nonpoint source controls to achieve LAs can be implemented through a number of existing programs such as Section 319 of the CWA, commonly referred to as the Nonpoint Source Program. Additionally, Virginia's Unified Watershed Assessment, an element of the Clean Water Action Plan, could provide assistance in implementing this TMDL.

The TMDL in its current form is designed to meet the applicable water quality standards. The Commonwealth intends to implement this TMDL through best management practices (BMPs). The implementation of these practices will occur in stages. This will allow the Commonwealth to monitor the benefits of the BMPs and determine which practices have the greatest impacts on water quality. It will also provide a mechanism for developing public support and checking the accuracy of the model.

8) The TMDLs have been subject to public participation.

Two public meetings were held to discuss TMDL development on Mill Creek and Pleasant Run. Both of these meetings were public noticed in the *Virginia Register* and opened to a thirty-day comment period. The first meeting was held on May 2, 2002 in VADEQ's Regional Office in Harrisonburg, VA. Seven people attended this initial meeting on the TMDL. Eleven people attended the second meeting which was held at VADEQ's Harrisonburg Office on July 23, 2002.